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Abstract

PLUTONIUM ENRICHED CERAMIC FUEL RODS IRRADIATION IN THE BR 3 POWER REACTOR

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Twelve plutonium - uranium oxide fuel rods have been introduced in the Belgian BR 3 reactor. The main objective of this experiment was to raise and to solve the technological problems concerning the fabrication of plutonium enriched fuel rods and to study their behaviour under the pressurized water power reactor operation conditions.

The fuel rods have been prepared by vibratory and swaging compaction of physically mixed dense UO_2 and UO_2 - PuO_2 powders. The main characteristics of these fuel rods are the following :

- Fuel material : UO_2 - 0,96 m/o PuO_2
- Density : vibrated rods : 86 % T D
  swaged rods : 91 % T D
- Dimensions : length : 150 cm

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outside diameter : 0,870 cm
thickness of the cladding : 0,050 cm
(stainless steel AISI 348)

At each fabrication step, destructive and non destructive controls have been made to estimate the quality of the used materials. The non destructive tests realized on the finished fuel rods essentially consist in controlling the end cap weldings and the canning thightness, the homogeneity of both the density and the plutonium enrichment, the integrity and the thickness of the cladding, the surface contamination, etc...

The twelve plutonium enriched rods have been distributed among 96 rods containing uranium oxide enriched to 3,7 % U^{235} and assembled with these latter by means of grids provided with springs (1). The assembly has been introduced in the core center in the beginning of November 1963. It will remain in the reactor core during at least 9 months (4000 hours at the equivalent full power of 40,9 MW th).

The computation of the plutonium enrichment (0,96 m/o) in the rods have been done by use of a geometrical model idealizing the reactor core when the fuel rods are introduced. The safety criterium adopted is the uniformity of the radial specific power distribution in the core. The nuclear study made it possible to estimate the maximum specific power generated by each rod at the beginning and at the end of the core life. At the standard power of 40,9 MW th, the maximum specific power in the plutonium loaded rods is about 330 W/cm, the average burn-up of the most highly rated rod will be close to 4800 MWd/t.

Prior to the introduction of the fuel rods in the reactor, different

researches have been carried out. Out of pile experiments have been made in order to determine the thermal conductivity of physically mixed UO_2 - PuO_2 powders densified by vibration and swaging. From the results of the measurements, the maximum central temperature of 1900° C $\pm$75° C has been evaluated in the plutonium fuel rods during the BR 3 operation. Fuel samples prepared by means of the same techniques and irradiated in the BR 2 high flux reactor have allowed to conclude that such a type of fuel may tolerate thermal heat fluxes of about 380 - 400 W/cm and burn-ups close to 1000/1100 MWd/t.

The reactor is actually in operation since November 25, 1963. The experiments still going on are one of the first objectives pursued by the BelgoNucléaire - C. E. N. Association researches on plutonium.

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(1) The U^{235} enriched fuel rods as well as the subassembly have been realized by the Belgian firm "Métallurgie et Mécanique Nucléaires" (MMN).